How Strong Is Your Tinder Game?
Strategic Two-Sided Search in Swipe-Based Dating App Markets

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Abstract

Your abstract here.

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Contents

1 Introduction

Points to discuss on introduction

- What is Tinder? (brief)
  - When was it started?
  - What is swiping?
  - How popular it is?
- Why does Tinder pose an interesting economic problem?
  - Stage interaction
  - Platform features: budgets, observability, directed search, asynchronicity
  - Repeated games: curse of dimensionality, beliefs and meta-beliefs
- What and how does this paper study?
  - Model of two-sided search with strategic considerations
  - Equilibrium refinement, computation, and analysis
  - Planner considerations on directed search and budget setting
- What does this paper contribute?
  - First model to address budgeted search in Tinder?
  - First model to combine idiosyncracy and pizzaz
  - Case study for the use of computational techniques in

1.1 Related Work

- Searching and Matching
  - Gale and Shapley (1962), Roth and Sotomayor (1992)
  - Two-sided: Burdett and Wright (1998), Chade (2006), Smith, Adachi
  - **Does not consider budgets**
    * ... important as this is a way for planners to influence outcomes
- Mean-Field Game Theory: Iyer et al. (2014), Gummadi et al. (2013), Jovanovic and Rosenthal (1988)
  - No models on MFG for Tinder
- Modern Dating Apps: Olmeda (2021), Kanoria and Saban (2021)
  - Not models where behaviour is derived from rational utility-maximizing assumptions

2 Model

2.1 Setup

- Who are the players?
  - Disjoint sets of men and women in the platform
  - They have pizzaz type $\mu, \omega \in [0, 1]$
- What do they do?
  - They get anonymously and sequentially partnered up
  - To their knowledge, this happens in a random manner.
  - They observe the suggestion's attractiveness $\theta \in [0, 1]$
  - They can choose to swipe left or right, thus $\mathcal{A} = \{0, 1\}$.
  - If they both swipe right on each other, they match. Note this doesn't mean they leave.
- What do they know?
  - Equally agents face a cap on the number of right swipes they have
  - B_m for men and
- What are their preferences?

2.2 The Dating Market

- Entry flows
- Leaves (including geometric lifetime)
- Distribution

2.3 The Search Problem

3 Equilibrium

3.1 Steady-State Equilibrium

3.2 Numerical Computation

3.3 Comparative Statics

4 Playing Cupid

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4.1 Directed Search: PageRank Suggestions

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5 Conclusion

In this chapter we shall do a reference to an entry in the bibliography, `bibliography.bib`.

What we know of the invention of the flux capacitor is that Dr. Emmett Brown thought of this when hanging a clock in the bathroom. He was standing on his porcelain sink and slipped because it was wet, the resulting hit on the head was apparently a cause to this invention Brown (1955).

5.1 Future Work

The corresponding sketch made on this day has been attached in appendix A.

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A Solving For The Market Steady State

A.1 Steady State Flow Equations

- Fix some strategies s_m, s_w and let:

$$\rho_m(\mu, b) = \mathbb{E}_{\theta_w}\Big[s_m(\theta, \mu, b)\Big] = \iint\limits_{[0,1]^2} s_m(\theta, \mu, b)\, dG(\theta|\omega)\, dW(\omega; s),$$

- Let $R_b^m = \mathbb{P}(\mu \in (\mu', \mu''], b; s)$
  - I.e. agents with pizzaz $\mu \in (\mu', \mu'']$ and budget b
  - Eg. $R_b^m = M(\mu'', b; s) - M(\mu'', b-1; s) - M(\mu', b; s) + M(\mu', b-1; s)$
  - and $R_1^m = M(\mu'', 1) - M(\mu', 1)$
- Fix any $\mu', \mu'' \in [0, 1]$. For all $\mu \in (\mu', \mu'']$ the steady state male market must satisfy the following flow equations:

$$\underbrace{\frac{\lambda_m}{N_w}\Big(F_m(\mu'') - F_m(\mu')\Big)}_{\text{Enters platform}} = \underbrace{(1-\delta)\sum_{b=1}^{B} R_b^m}_{\text{Exogenous death}} + \underbrace{\delta R_1^m \int_{\mu'}^{\mu''} \rho_m(\mu, 1)\, dM(\mu; s)}_{\text{Expended budget}} \quad \text{(A.1)}$$

$$\underbrace{\delta R_{b+1}^m \int_{\mu'}^{\mu''} \rho_m(\mu, b+1)\, dM(\mu; s)}_{\text{Enters b}} = \underbrace{(1-\delta) R_b^m + \delta R_b^m \int_{\mu'}^{\mu''} \rho_m(\mu, b)\, dM(\mu; s)}_{\text{Leaves b}} \quad \text{(A.2)}$$

$$\underbrace{\frac{\lambda_m}{N_m}\Big(F_m(\mu'') - F_m(\mu')\Big)}_{\text{Enters platform}} = \underbrace{(1-\delta) R_B^m + \delta R_B^m \int_{\mu'}^{\mu''} \rho_m(\mu, B)\, dM(\mu; s)}_{\text{Leaves @ B}} \quad \text{(A.3)}$$

A.2 Solving for the Endogenous Type Distribution

- With an abuse of notation, let the probability of someone in R_b^m swiping right be:

$$\bar{\rho}_m(b) = \int_{\mu'}^{\mu''} \rho_m(u, b)\, dM(u; s)$$

- Solve for R_B^m from (A.3)

$$R_B^m = \frac{\lambda_m\Big(F_m(\mu'') - F_m(\mu')\Big)}{N_m\Big((1-\delta) + \delta\bar{\rho}_m(B)\Big)}$$

- Rearrange for R_b^m using (A.2)

$$R_b^m = \underbrace{\frac{\delta\bar{\rho}_m(b+1)}{\Big((1-\delta)+\delta\bar{\rho}_m(b)\Big)}}_{k_b} R_{b+1}^m$$

- By the above recurrence relation:

$$\begin{aligned}
R_{B-1}^m &= k_{B-1}R_B^m \\
R_{B-2}^m &= k_{B-2}R_{B-1}^m \\
&= k_{B-2}(k_{B-1}R_B^m) \\
&\vdots \\
R_b^m &= R_B^m \prod_{i=1}^{B-b} k_{B-i}
\end{aligned}$$

- Let $\mu'' = 1$ and $\mu' = 0$. Then $R_b^m = \mathbb{P}_m(b_m = b; s)$
- Given that b is discrete and the above defines a PMF, we also have:

$$\mathbb{P}_m(b_m = b; s) = R_B^m \prod_{i=1}^{B-b} k_{B-i}$$

$$\implies M_b(b; s) = R_B^m \sum_{j=1}^{b} \prod_{i=1}^{B-j} k_{B-i}$$

- Let $\mu'' = \mu$ and $\mu' = 0$. Then:

$$R_b^m = M(\theta, b; s) - M(\theta, b-1; s) = \mathbb{P}_m(\theta_m < \theta \cap b_m = b; s)$$

- By substituting the extended form for the above two cases and rearranging:

$$M_\theta(\theta|b_m = b; \mu, \omega) = \frac{\mathbb{P}_m(\theta_m < \theta \cap b_m = b; \mu, \omega)}{\mathbb{P}(b_m = b; \mu, \omega)} = F_m(\theta)$$

- To solve for $M(\theta, b; \mu, \omega)$

$$\begin{aligned}
M(\theta, b; \mu, \omega) &= \sum_{j=1}^{b} M_\theta(\theta|b_m = j; \mu, \omega)\mathbb{P}_m(b_m = j; \mu, \omega) \\
&= F_m(\theta) R_B^m \sum_{j=1}^{b} \prod_{i=1}^{B-j} k_{B-i} \\
&= F_m(\theta) M_b(b; \mu, \omega)
\end{aligned}$$

- Letting $b = B$, we get the marginal distribution for θ_m:

$$M(\theta, B; \mu, \omega) = F_m(\theta) M_b(B; \mu, \omega) = F_m(\theta) = M_\theta(\theta; \mu, \omega)$$

- Hence, we have:

$$
\begin{aligned}
\mathbb{P}_m(b_m = b; \mu, \omega) &= \frac{\lambda_m}{N_m\Big(1-\delta(1-\rho^m_B)\Big)} \prod_{i=1}^{B-b} \frac{\delta \rho^m_{B-i+1}}{\Big(1-\delta(1-\rho^m_{B-i})\Big)} \\
M_b(b; \mu, \omega) &= \sum_{i=1}^{b} \mathbb{P}_m(b_m = i; \mu, \omega) \\
M_\theta(\theta; \mu, \omega) &= F_m(\theta) \\
M(\theta, b; \mu, \omega) &= M_\theta(\theta; \mu, \omega) M_b(b; \mu, \omega)
\end{aligned}
$$

Tying up The Steady State

- Consider the above arguments for the analogous case for women - Since we know the marginal attractiveness distribution for women in the steady state is equal to $F_w(\theta)$ then the expected probability of a right-swipe for men ρ^m_b is expressed as below, with an analogous expression for women

$$
\rho^m_b = \int_{\Theta_w} \mu(\theta', b)\, dW_\theta(\theta'; \mu, \omega) = \int_{\Theta_w} \mu(\theta', b)\, dF_w(\theta')
$$

- Substitute into the first set of flow equations to solve for - Furthermore, let:

$$
z^m_b = \prod_{i=1}^{B-b} \frac{\delta \rho^m_{B-i+1}}{\Big(1-\delta(1-\rho^m_{B-i})\Big)}, \quad \forall b = 1, ..., B_m - 1
$$

$$
z^w_b = \prod_{i=1}^{B-b} \frac{\delta \rho^w_{B-i+1}}{\Big(1-\delta(1-\rho^w_{B-i})\Big)}, \quad \forall b = 1, ..., B_w - 1
$$

$$
z^m_B = \Big(1-\delta(1-\rho^m_B)\Big)
$$

$$
z^w_B = \Big(1-\delta(1-\rho^w_B)\Big)
$$

- Then the steady state is given by:

$$
N_m(\mu, \omega) = \lambda_m \left(\frac{z^m_B - \delta z^m_1 \rho^m_1}{(1-\delta) z^m_B} \right)
$$

$$
N_w(\mu, \omega) = \lambda_w \left(\frac{z^w_B - \delta z^w_1 \rho^w_1}{(1-\delta) z^w_B} \right)
$$

$$
M(\theta, b; \mu, \omega) = F_m(\theta) \left(\frac{(1-\delta)}{z^m_B - \delta z^m_1 \rho^m_1} \right) \sum_{i=1}^{b} z^m_i
$$

$$
W(\theta, b; \mu, \omega) = F_w(\theta) \left(\frac{(1-\delta)}{z^w_B - \delta z^w_1 \rho^w_1} \right) \sum_{i=1}^{b} z^w_i
$$

B Uniqueness and Existence of Search Problem